Strategic effects in associative priming with words, homophones and pseudohomophones

Denis Drieghe and Marc Brysbaert

Ghent University

Address: Denis Drieghe
Department of Experimental Psychology
Ghent University
Henri Dunantlaan 2
B-9000 Ghent
Belgium
Tel. 32 – 9 - 264 64 09
Fax. 32 – 9 - 264 64 96
e-mail: Denis.Drieghe@rug.ac.be

Abstract

In Dutch we presented a target (e.g. *been [leg]*), preceded by an associate (e.g. *bot [bone]*), a homophone (e.g. *bod [offer]*), or a visual control (e.g. *bom [bom]*). We also presented a target (e.g. *man [man]*), preceded by an associate (e.g. *vrouw [woman]*), a pseudohomophone (e.g. *vrauw*), or a visual control (e.g. *vreuw*). At a prime exposure time of 57 milliseconds we replicated the results of Lukatela and Turvey (1994a) using both a naming task and a less phonology-demanding task, the lexical decision task. Homophonic and pseudohomophonic priming were equal in strength as the appropriate associate. Using a lexical decision task and a prime exposure time of 258 milliseconds we replicated the results of Lukatela and Turvey (1994a) who used a naming task: pseudohomophonic priming was as strong as the appropriate associate in priming the target, while homophonic priming had diminished. The latter effect would be due to a verification process (Van Orden, 1987). In experiment 4 the possibility of strategic effects was examined using a lexical decision task with a prime exposure time of 57 milliseconds and a non-word list consisting entirely of pseudohomophones: Pseudohomophonic priming was unaltered while homophonic priming diminished. These results indicate an accelerated verification process resulting in (post)lexical strategic effects.

Strategic effects in associative priming with words, homophones and pseudohomophones

In the dual-route model of visual word recognition (Coltheart, 1978; Coltheart, Curtis, Atkins, & Haller, 1993; Coltheart, Rastle, Perry, Langdon, & Ziegler, in press) it has been assumed that skilled readers prefer the direct visual route for visual word processing, because the indirect phonological route includes an additional conversion from orthography to phonology, making it potentially slower. This idea has dominated research on visual word processing for a long time, and some authors even suggested that the existence of the phonological route could be rejected without loss of generality (e.g., Humphreys & Evett, 1985). Indications, however, exist that phonology plays a more crucial role in the process of visual word recognition.

Using a masked priming paradigm, in which target words were preceded by a tachistoscopically presented prime, Humphreys, Evett, and Taylor (1982) discovered that more targets (e.g. *MADE*) were recognized when the prime was a homophone (*maid*) than when it was an unrelated word (*ship*) or a graphemic control word (*mark*). So automatic phonological priming existed in English, but was it lexical or non-lexical? To examine this question, Humphreys et al. designed the pseudohomophone test. If they could replicate the effect with homophonic non-word primes instead of homophonic word primes, then the phonological priming had to originate from a non-lexical route, as non-words do not have a representation in the mental lexicon. However, Humphreys et al. failed to find such an effect, making them conclude that the priming they had found with homophones was a lexical effect. Almost a decade later, Perfetti and Bell (1991) replicated the null-effect of Humphreys et al., but showed that this was only true for short prime presentation times (up to 35 milliseconds). When primes were presented for a slightly longer duration (45 and 65 milliseconds), a clear phonological priming effect was obtained with non-word primes. Shortly afterwards, Lukatela and Turvey (1994b) even found significant phonological priming with better-controlled pseudohomophones at a prime presentation time as short as 30 milliseconds. So, automatic phonological priming can occur through a non-lexical route. These results were in agreement with previous findings using the backward masking paradigm (Perfetti, Bell, & Delaney, 1988).

Other important phonological effects were obtained with a rapid semantic categorization task. Van Orden (1987) discovered that participants frequently made errors in this task when homophones were used as stimulus materials. Participants were first shown the name of a category (e.g. *FLOWER*) followed by a target (e.g. *ROSE*), after which they had to decide as fast as possible whether the target belonged to the category or not. When appropriate target words (*ROSE*) were replaced by homophones (*ROWS*), the number of misclassifications was significantly higher than when target words were replaced by visual controls (*ROBS*). Van Orden attributed the extra percentage of misclassifications to the fact that visual letter strings must be converted into a phonological representation before they can make contact with stored word information. Because ROSE and ROWS activate the same pre-lexical phonological code, they are indistinguishable in the first stage of lexical access. When sufficient time is available, a spelling verification process is thought to occur in order to resolve the ambiguity caused by the homophone. This explains why the error rate introduced by homophones is low under free viewing conditions and depends on the orthographic overlap between homophone and target word. The delayed spelling check also explains why the error rate increases dramatically when exposure time is limited, and why under these conditions error rate no longer depends on the degree of orthographic overlap.

Lesch and Pollatsek (1993) reported further evidence for Van Orden's verification model using an associative priming experiment. Participants had to name a target word (e.g. *sand*) as fast as possible. The target was preceded by a masked prime that belonged to one of three different categories: the appropriate associate prime (e.g. *beach*), a homophone of the associate prime (*beech*), or an orthographic control (*bench*). Lesch and Pollatsek found that if the prime was presented for a very short period of time (50 ms) targets were named faster both when they were preceded by the associate prime and when they were preceded by the homophonic prime than when they were preceded by the orthographic control prime. In addition, the priming effect was equally strong for the homophonic primes as for the true associates. However, when prime presentation time was increased to 200 ms, there was no priming of the homophones any more, whereas the effect of the associate primes remained significant. Lesch and Pollatsek considered their results as evidence for the verification model and ventured that at 200 ms the spelling verification process had enough time to take place, whereas this was not the case at 50 ms.

Lukatela and Turvey (1994a) expanded the results of Lesch and Pollatsek (1993) by showing that the same effects were obtained with pseudohomophones as primes (i.e. *tode*, a pseudohomophone of *toad*, primed the naming of the target word *frog*). In addition, they found that, unlike homophone primes, pseudohomophone primes remained to have an effect at long prime presentation durations (250 ms). Lukatela and Turvey attributed this difference to the fact that pseudohomophones, being non-words, had no representation in the lexicon, so that the verification process could not resolve the ambiguity introduced by the pseudohomophone. Finally, Lukatela and Turvey (1994a) compared the naming latencies for target words preceded by an orthographic control prime and by a totally unrelated prime. They found no difference between these two conditions and argued that this finding was evidence against the existence of an independent orthographic route in visual word recognition.

On the basis of the above results, an increasing number of researchers has started to claim that the phonologically mediated route may be the only one that matters in visual word recognition (e.g. Berent & Perfetti, 1995; Frost, 1998). Other researchers still believe there is enough evidence for an independent visual route (e.g. Coltheart et al., 1993, in press; Ferrand & Grainger, 1994). A commonly heard criticism of the latter group is that many of the important experiments in which strong phonological effects were observed (e.g. Lesch & Pollatsek, 1993; Lukatela & Turvey, 1994a; Lukatela & Turvey, 1994b), made use of the naming task. This task could artificially boost the reliance on phonological information (e.g. Frost, 1998). Already from the first version of the dual-route model (Coltheart, 1978), it was assumed that people could control the weight given to the visual and the phonological route. When phonology helps to perform the experimental task, participants can increase the importance attached to the non-lexical, phonological pathway. Several experiments have been reported that showed such strategic effects in a variety of tasks. In the lexical decision task, for instance, it has been observed that participants rely less on phonology when many pseudohomophones are included in the non-word trials (Davelaar, Coltheart, Besner, & Jonasson, 1978; McQuade, 1981; Milota, Widau, McMickell, Juola, & Simpson, 1997; Pugh, Rexer & Katz, 1994). In naming, Monsell, Graham, Hughes, Patterson and Milroy (1992) observed a larger word frequency effect when the target words were mixed with irregular words than when they were mixed with non-words (also see Zevin & Balota, 2000). Monsell et al. attributed this effect to the idea that participants relied more on the visual, lexically mediated route when the stimulus list contained a lot of irregular words, whereas they relied more on non-lexical, assembled phonology in the context of many non-words (that do not have a lexical representation). Finally, Hawkins, Reicher, Rogers, and Peterson (1976) showed that participants in a word identification task relied less on phonology when they often had to choose between two homophones (e.g. *sent, cent*) than when in the majority of trials they had to choose between two heterophones (*cold, sold*).

Researchers defending the strong phonological view of visual word recognition have argued that the strategic effects listed above, are due to reliance on lexically-mediated, addressed phonology and say little about pre-lexical phonology assembly (Berent & Perfetti, 1995; Frost, 1998). The basic idea (Frost, 1998) is that lexical access may be based on a partial phonological code. This code is automatically activated and can be enriched after lexical access. So, strategic phonological effects will be observed when the experimental task requires a rich phonological representation (e.g., in word naming), but automatic effects will be seen if the task taps into the very first, pre-lexical stages of word processing. The prototypical task of the latter type is the masked priming paradigm, in which target words are immediately preceded by barely visible primes that need not to be processed consciously. It is this task which Lukatela and Turvey (1994a) and Lesch and Pollatsek (1993) used.

In our experiments, we concentrated on three questions. First, is it possible to replicate Lukatela and Turvey's (1994a) findings in Dutch? Second, is the phonological priming effect confined to word naming or can it be extended to lexical decision? And third, what happens if we discourage reliance on phonological information by having participants exclusively decide between words and pseudohomophones in the lexical decision task? The first question is addressed in Experiment 1. Although Lukatela and Turvey claimed their findings were universal (at least for alphabetic languages) and although they presented quite some evidence for similar effects in Serbo-Croatian (see Lukatela & Turvey, 1998, for a review), it must be taken into account that the first evidence of phonological recoding in Dutch was far from convincing (Brysbaert & Praet, 1992). Using a backward masking paradigm, these authors only got a significant phonological masking effect when the majority of trials contained pseudohomophonic masks. Brysbaert and Praet's findings have been criticized on various grounds (e.g., Xu & Perfetti, 1999), but only recently has it become clear that phonological effects in Dutch are difficult to obtain with the backward masking paradigm and can be more easily observed with the masked priming technique (Brysbaert, 2000). Whatever the exact reason of Brysbaert and Praet's (1992) findings, they warn us that nothing sensible can be said about the extension of the phonological priming effect to the lexical decision task, if the effect has not first been replicated with the original naming task. The lexical decision task is used in Experiment 2 (with a prime duration of 57 ms and legal non-words), Experiment 3 (prime duration of 258 ms, legal non-words), and Experiment 4 (57 ms prime duration, pseudohomophonic non-word trials). In all experiments, the associative priming effect of homophones and pseudohomophones is compared to the priming effect of real associates and orthographic control primes. Experiment 4 was added to examine possible strategic effects in the use of phonology. Any difference in the results between Experiments 2 and 4 indicates the presence of such effects in the reliance on pre-lexical phonological information.

The construction of the stimuli

Because Lukatela and Turvey's (1994a) findings in the first place depend on the availability of good pairs of associated words, one of which has a pseudohomophone or a homophone, we invested quite some energy in the construction of our stimulus materials. A list of 42 pairs of homophones (e.g. *rat [rat], rad [wheel]*) and 42 words that could be written as pseudohomophones (e.g. *auto [car], outo*) was selected. These 126 words (42 x 2 "homophonic" words + 42 "pseudohomophonic" words) were distributed over 6 lists of 21 words (so that a single list did not contain both members of a homophonic pair). Each list was scored by 40 different first-year students from Ghent University (making a total of 240 raters) who did not participate in any of the following experiments. The students were asked to write down as quickly as possible the first association that came in mind when seeing each stimulus word.

Out of the 126 words that had been scored, two lists of 21 experimental prime trials were built. The first list consisted of the best "homophonic" primes, that is those words of a pair of homophones that had the most frequent associate (remark that maximum one member per homophonic pair could be selected). The mean associate generation frequency for these words was 54.8%. Similarly, the 21 best "pseudohomophonic" primes were selected (mean generation frequency = 46.1%). They made up the second list.

The 21 primes of the first list (e.g. *hart [heart]*) were matched to their homophone (*hard [hard]*) and to an unrelated orthographic control word (*hars [resin]*) that had the same number of letters in common with the original prime and that was of roughly the same frequency as the homophone. These stimuli are listed in Appendix A. The 21 primes of the second list (e.g. *arm [arm]*) were matched to their pseudohomophone (*arrem*) and to an orthographic control non-word (*ars*; see Appendix B). All these stimuli were used as primes of the associates that had been generated by the students and that served as targets in the experiments below (e.g., *liefde [love]* was the target of the primes *hart, hard, hars*; and *hand [hand]* was the target of the primes *arm, arrem, ars*).

The remaining words that had been rated, were used to create non-word trials for the lexical decision experiments. These trials were created exactly the same as the word trials, except that after the creation one of the letters of the target words was changed in order to create either a legal non-word or a pseudohomophone (see Appendices C-F). So, after having combined the target word *vijs [screw]* with the primes *bout [bolt], boud [bold], mout [malt]*, the target was changed into the non-words *lijs* or *veis* and presented with the same primes.

In the Lukatela and Turvey's (1994a) experiments, the effect of prime frequency was examined by constructing 2 sublists: One list with high-frequency associative primes and low-frequency homophonic primes, and one list with the reverse pattern. This did not induce a systematic difference, nor did prime frequency in related research on phonological priming (Ferrand & Grainger, 1992; Lukatela & Turvey, 1994b; Lukatela, Lukatela, Carello, & Turvey, 1999). For this reason, we did not fully control the variable frequency in this study.

Experiment 1

As indicated in the introduction, Lukatela and Turvey (1994a) found evidence of homophonic and pseudohomophonic mediated associative priming in the naming task. Target word naming (e.g. *frog*) was about 10 ms faster not only when the word was combined with a real associative prime (*toad*), but also when it was combined with a homophone (*towed*) or a pseudohomophone (*tode*). Prime exposure duration was 50 ms. This experiment was set up to replicate the effect in Dutch.

Method

Participants. Participants were 39 first-year university students, who participated for course credits. All were native Dutch speakers.

Stimulus Materials. The experimental list for the homophonic priming is described in Appendix A and the experimental list for the pseudohomophonic priming in Appendix B. Both lists were mixed and presented to the same participants.

Procedure. The main constraint of the experimental design was that a participant never saw a target word twice. This was achieved by using a Latin-square design. As there were three prime types (associate, homophone or pseudohomophone, and graphemic control), each participant named only one third of the target words in each condition. Across participants, all words were presented in all conditions. Participants received a random permutation of the 42 experimental trials mixed with 42 unrelated filler trials. Before this series of trials was presented, a practice series of 28 trials was completed. Of these 28 trials, 14 prime – target pairs were associated and 14 were not. Participants were tested individually.

A trial started with a visual warning signal (a forward mask consisting of #######) presented for 1 s, immediately followed by the presentation of the prime for 57 ms, and the target. Stimulus presentation was synchronized with the refresh cycle of the screen (70 Hz). As in Lukatela and Turvey (1994a), the prime was presented in uppercase letters and the target in lowercase letters. The target word remained on the screen until the voice key registered a response. The experimenter registered on-line the correctness of the response and the time registration. The interstimulus interval was 1 s. Throughout the experimental session, two vertical lines were visible in the middle of the screen. These lines were presented one above the other with a gap of 1 cm between them. Participants were instructed to look at the gap between the two lines as soon as the visual warning signal appeared. Stimuli were presented so that the second letter always appeared between the lines. Previous research has shown that the second letter is the optimal viewing position for recognizing short words in Dutch (Brysbaert, Vitu, & Schroyens, 1996). Participants were instructed that a word would appear between the lines shortly after the warning signal and that they had to pronounce the word as rapidly as possible. The presence of a prime stimulus was not mentioned.

Results

Naming latencies were excluded from the analyses below when (i) the word had been pronounced incorrectly, (ii) the voice key had not registered the voice onset time correctly, and (iii) when RTs were lower than 100 ms or higher than 1500 ms. All in all, 5.2 % of the data were discarded mostly because the response had been too weak to trigger the voice key.

Insert table 1 about here

Table 1 lists the naming latencies of the target words as a function of prime type. Remember that there were two different lists, one with homophones and one with pseudohomophones. These lists were analyzed separately. Because a Latin square design was used with relatively few observations in the different cells, the group variable was included in all analyses reported below. If this is not done, the power of the design may be deflated because of random fluctuations between the participants or between the stimuli allocated to the different cells (Brysbaert & Mitchell, 1996; Pollatsek and Well, 1995). All analyses were run over participants (F1-analyses) and stimulus materials (F2-analyses). The p-values were smaller then .05, unless indicated otherwise.

For the list with homophones, target words were named 26 ms slower after graphemic control primes than after associate primes or homophonic primes. This effect of prime type was significant ($F1(2,72) = 4.24$, $MSe = 2077.71$; $F2(2,36) = 5.81$, $MSe = 897.86$) and completely due to the difference between the graphemic controls on the one hand and the associates and homophones on the other hand (Duncan's multiple range test at .05: F1, step 1 = 20.6, step 2 = 21.7; F2, step 1 = 18.7, step 2 = 19.7).

The same pattern was found for the list with pseudohomophones. The 23 ms slower RTs after graphemic control primes was significantly different from the RTs after associate primes and pseudohomophonic primes ($F1(2,72) = 4.35$, $MSe = 1675.88$; $F2(2,36) = 3.95$, $MSe = 784.11$; Duncan's multiple range test at .05: F1, step 1 = 18.5, step 2 = 19.4; F2, step 1 = 17.5, step 2 = 18.4).

Discussion

Experiment 1 successfully extended Lukatela and Turvey's (1994a) associative priming experiment to the Dutch language. The same priming effect was obtained with true associates as with homophones of these associates (26 ms), or with true associates and their pseudohomophones (23 ms; see Table 1). The finding that Lukatela and Turvey (1994) could be replicated in Dutch, adds further evidence to the claim that phonological coding of visually presented words plays a crucial role in all alphabetic languages and puts us in a good position to see whether the effect can be generalized to a lexical decision experiment.

EXPERIMENT 2

In this experiment, participant had to decide between words and legal non-words. Targets were preceded by the same primes as in Experiment 1.

Method

Participants. Participants were 42 first-year students, who participated for course credits. All were native Dutch speakers.

Procedure. The design was the same as in Experiment 1, except that now the 42 filler trials were replaced by 42 non-word trials. The non-word trials either followed the logic of the homophone list (Appendix C) or the logic of the pseudohomophone list (Appendix D). Before the experimental list of 84 randomly mixed trials, a practice series of 28 trials was finished. The practice series had been constructed along the same lines as the experimental list. Stimulus presentation was the same as in Experiment 1, except that participants had to indicate their word/non-word decision by pressing a button with the left or the right hand (counterbalanced across participants). External response boxes were used, connected to the game port.

Results

The results of the non-words were not analyzed. RTs below 100 ms and above 1500 ms were considered as outliers and removed from the data analysis. This was the case for 1 out of 1,764 observations. Response latencies and percentages of errors are listed in Table 2. As the error rate was very small and did not contradict the conclusions of the RTs, this variable was not analyzed.

Insert table 2 about here

For the list with homophones, RTs were about 24 ms slower when target words were preceded by graphemic control primes than when they were preceded by either associates or homophones. The effect of prime type was significant ($F1(2,78) = 3.93$, $MSe = 2405.27$; $F2(2,36) = 4.10$, $MSe = 1181.47$) and due to the difference between the graphemic controls on the one hand and the associates and homophones on the other hand (Duncan's multiple range test at .05: F1, step 1 = 21.3, step 2 = 22.4; F2, step 1 = 21.5, step 2 = 22.6).

The same pattern was obtained for the list with pseudohomophones. The 30 ms slower RTs after graphemic control primes was significantly different from the RTs after associate primes and pseudohomophonic primes ($F1(2,78) = 7.86$, $MSe = 1842.63$; $F2(2,36) = 10.81$, $MSe = 623.97$; Duncan's multiple range test at .05: F1, step 1 = 18.6, step 2 = 19.6; F2, step 1 = 15.6, step 2 = 16.4).

Discussion

Experiment 2 successfully extended the phonological priming effect to the lexical decision task. We obtained an associative priming effect of homophones that was of the same magnitude as the priming caused by real associates (respectively 28 and 24 ms). The same was true for the comparison between pseudohomophones and real associates (priming effects of respectively 30 and 34 ms). This indicates that Lukatela and Turvey's (1994a) effect was not due to task characteristics. The naming task is a task that intrinsically requires phonology (Frost, 1998); this is not necessarily the case for lexical decision. Still we find the same effect, indicating the robustness of the effect.

Experiment 3

In the previous experiments, we found similar effects with homophones as with pseudohomophones. This was expected on the basis of Lukatela and Turvey (1994a) and

Lesch and Pollatsek (1993). If prime duration is short, there is not enough time to perform a spelling check on the primes. Different results have been obtained with longer prime exposure durations (200-250 ms). Under these conditions, phonological priming of target naming can still be observed with pseudohomophones but not homophones (Lesch & Pollatsek, 1993; Lukatela & Turvey, 1994a). The present experiment was set up to find out whether the same pattern of results emerges in the lexical decision task.

Method

Participants. Participants were 42 first-year students, who participated for course credits. All were native Dutch speakers.

Procedure. Everything was the same as in Experiment 2, except that prime exposure time now was 258 milliseconds (18 refresh cycles of the screen) and that the experiment was run with 4 participants (and computers) in parallel.

Results

The results of the non-words were not analyzed. Naming latencies below 100 ms and above 1500 ms were removed. This was the case for 15 out of 1,764 observations. Table 3 lists the RTs and percentages of errors as a function of stimulus list and prime type.

Insert table 3 about here

For the list with homophones, RTs were about 25 ms faster when target words were preceded by their associate than when they were preceded by a homophone or a graphemic control. The effect of prime type was significant ($F1(2,78) = 5.78$, $MSe = 1360.22$; $F2(2,36) = 3.67$, $MSe = 1195.51$). In contrast with the previous experiment, this time the effect was due to the difference between the associates on the one hand and the homophones and graphemic controls on the other hand (Duncan's multiple range test at .05: F1, step 1 = 21.6, step 2 = 22.8; F2, step 1 = 16.0, step 2 = 16.9).

The RT pattern for the list with pseudohomophones was a replica of the pattern found in Experiments 1 and 2. The 17-22 ms slower RTs after graphemic control primes was significantly different from the RTs after associate primes and pseudohomophonic primes ($F1(2,78) = 4.16$, $MSe = 1367.32$; $F2(2,36) = 5.62$, $MSe = 614.60$; Duncan's multiple range test at .05: F1, step 1 = 15.5, step 2 = 16.3; F2, step 1 = 16.1, step 2 = 17.0). However, the percentage of errors yielded a slightly different picture: Here, there were more errors after a non-word prime (either pseudohomophonic of not) than after a word prime ($F1(1,39) = 11.85$, $MSe = 4.32$, $F2(1,18) = 18.95$, $MSe = 9.47$).

Discussion

The results of Experiment 3 fully agree with the predictions derived on the basis of Lukatela and Turvey (1994a) and Lesch and Pollatsek (1993). If primes are presented long enough for the spelling check to take place, then it is no longer possible to prime a target word with a homophone of the associate, although it is still possible to prime a target word with a pseudohomophone of the associate (see Table 3). The only deviating figure is that the error rate is higher after a pseudohomophonic prime (6.4%) than after a associate prime (1.4%). This may have to do with the fact that non-word primes more easily evoke a non-word response than word primes (Klinger, Burton, & Pitts, 2000).

So far, we have found exactly the same phonological priming effects with the lexical decision task as with the naming task. This is interesting because there are no a priori reasons why lexical decision would require the same reliance on phonological information as correct word naming. On the other hand, it could be argued that although the lexical decision tasks we used in Experiments 2 and 3 did not demand phonological recoding, they did not discourage it either. Because the non-words differed from existing words both in letters and in sounds, it may have been interesting for the participants to address the phonological information in order to speed up the decision process. As Brysbaert and Praet (1992) noted, evidence for *automatic* phonological coding of visually presented words can only be obtained under conditions that strongly discourage the use of phonology. This is what we looked at in the next experiment.

Experiment 4

In Experiment 4 we examined to what extent the phonological priming effect found in the previous experiments, is an automatic effect or can be strategically controlled by the reader. This was done by creating a condition in which the use of phonological information would be detrimental for correct task performance. Two modifications were introduced to the design of Experiment 2. First, all legal non-word targets were replaced by pseudohomophones, so that the word/non-word decision could no longer be based on differences in sound between both types of stimuli. In the past, strategic effects in the use of phonology have been reported with a 33 % rate of pseudohomophones in the non-word trials (Ferrand & Grainger, 1996), but we wanted to make our test as strong as possible. The second change we introduced, concerned the instructions given to the participants. In Experiment 4, participants were told in advance that they had to choose between words and non-words that sounded like words, so they had to be very careful not to make a lot of mistakes. Because the type of non-words and the instructions were the only aspects that changed between Experiment 2 and Experiment 4, any change in results must be due to strategic effects on the part of the participants.

Method

Participants. Participants were 42 first-year students, who participated for course credits. All were native Dutch speakers.

Procedure. The 42 word trials were the same as in the previous experiments. The 42 non-word trials (Appendix E and F) were made by creating pseudohomophones of the associates given in the associate generation study discussed in the introduction. Whenever possible, we used the most frequent associate given. However, on some occasions we had to go to the second most frequent (or in 2 cases the third most frequent) associate before we could find an acceptable pseudohomophone of the target word. Apart from the instructions (i.e., the warning that the non-words sounded like read words), the procedure was exactly the same as in Experiment 2. In particular, this means that the primes were presented for 57 ms.

Results

The results of the non-words were not analyzed. Naming latencies below 100 ms and above 1500 ms were discarded. This was the case for 5 out of 1,764 observations. Because error rate was very low, it was not analyzed either. Decision latencies and percentages of error as a function of stimulus list and prime type are presented in Table 4.

Insert table 4 about here

For the list with homophones, there was a clear 26 ms effect of associate priming, that was virtually the same as that in Experiment 2 (24 ms), giving rise to a significant effect of prime type ($F1(2,78) = 5.98$, $MSe = 2098.14$; $F2(2,36) = 4.76$, $MSe = 1388.36$). However, contrary to Experiment 2, the condition with homophone primes yielded the same decision latencies as the condition with control primes and differed significantly from the condition with associate primes (Duncan's multiple range test at .05: F1, step 1 = 19.9, step 2 = 20.9; F2, step 1 = 23.3, step 2 = 24.5).

For the list with pseudohomophones, the pattern of results was an exact replica of those of Experiment 2: There was a 31 ms difference between associate primes and graphemic control primes (34 ms in Experiment 2), and there was a 26 ms difference between pseudohomophones and graphemic controls (30 ms in Experiment 2), giving rise to a significant effect of prime type ($F1(2,78) = 5.42$, $MSe = 2136.03$; $F2(2,36) = 6.26$, $MSe = 944.78$). In addition, the decision latencies after a pseudohomophonic prime were the same as after an associate prime and differed from those after a graphemic control prime (Duncan's multiple range test at .05: F1, step 1 = 20.1, step 2 = 21.1; F2, step 1 = 19.2, step 2 = 20.2).

Discussion

Experiment 4 was designed with two possible outcomes in mind. Either prelexical phonological priming was automatic and then we would find the same pattern of results as in Experiment 2, or phonological priming was under strategic control and then we would find no priming from homophones or pseudohomophones because we encouraged the participants not to make use of phonological information. As it turned out, the results were a mixture of both predictions and patterned like the data of Experiment 3 in which a long prime exposure duration was used. Phonological priming was still observed with pseudohomophones but not with homophones. The implications of these findings for theories of phonological mediation in visual word recognition will be discussed in the next section.

General Discussion

In recent years, a strong phonological model of visual word recognition has been promoted according to which the orthographic stimulus is first translated into a partial phonological code that makes access to stored word information. Once the stored representation has been activated, additional information about the exact pronunciation and spelling becomes available. In such a view, pre-lexical phonological coding is mandatory but the use of lexically supported phonology may be under strategic control (e.g., Berent & Perfetti, 1995; Frost, 1998; Gibbs & Van Orden, 1998; Xu & Perfetti, 1999).

Berent (1997) directly addressed the issue of mandatory pre-lexical phonological assembly versus strategic reliance on post-lexical phonology by running a lexical decision task in which the target words were preceded by masked primes. Some of the target words had a regular pronunciation (e.g., *scoop*), other had an irregular pronunciation (e.g., *glove*); some target words were preceded by a homophonic prime, some by a graphemic control prime. Although Berent failed to find an effect of the spelling-sound regularity of the target words with legal non-word foils (indicating that the lexical decision did not incorporate this kind of phonological information), she still obtained faster decision times after homophonic primes than after graphemic control primes (indicating that pre-lexical phonology assembly did matter in the task).

Other evidence that word processing may be different in the very first, pre-lexical stages than in the later (post-)lexical stages comes from Lukatela and Turvey (1994a). These authors reported associative priming of both homophones and pseudohomophones at a prime exposure time of 50 milliseconds. However, at a prime exposure duration of 250 ms, priming with homophones was no longer observed, even though it was still possible to prime target words with pseudohomophones of the associates. Lukatela and Turvey explained this finding by assuming (a) automatic pre-lexical activation of phonology, and (b) the existence of lexically based spelling verification process that could clean up ambiguities raised by the phonological code (Van Orden, 1987).

The present experiments were set up as a further test of the strong phonological model of visual word recognition. If pre-lexical phonology is mandatory then it should be observed for all alphabetic languages and for other tasks than word naming. In addition, if the recoding is not under strategic control, then traces of it must be found under conditions that strongly discourage the use of phonological information. By and large, all three predictions were confirmed. Lukatela and Turvey's (1994a) findings could be generalized to the Dutch language and to the lexical decision task, and a pseudohomophonic priming effect was observed in a word/pseudohomophone decision task, that strongly discouraged the reliance on phonology. The only result that deviated was the observation that we could not prime a word by a homophone of an associate in the word/pseudohomophone decision task, even though prime presentation time was limited to 57 ms.

To understand the significance of this finding, it is important to keep in mind that the absence of a phonological priming effect with homophones is not thought to be due to an absence of phonological mediation in visual word processing but to the presence of a lexically mediated process. The fact that we always found a priming effect with the pseudohomophones indicates (a) that in all our experiments phonological information was activated, and (b) that this phonology was unlikely to be lexically mediated (cf. the pseudohomophone test of Humphreys et al., 1982). The finding that we sometimes could not prime with homophones, therefore, indicates that (a) a lexically-based spelling check can clean up the ambiguity created by two homophones if there is enough time (258 ms; Experiment 3), or (2) even faster (at 57 ms; Experiment 4) if the task encourages the participants to rely predominantly on orthographic information. So, what our results tell us is not that there is strategic control over the pre-lexical activation of phonology, but that there may be some lexical control over the efficiency to disambiguate this information. In particular, it looks like the spelling verification process can be pushed to intervene faster than it usually does. The fact that this is only possible for known words (homophones) suggests that the verification is lexically based indeed (Lukatela & Turvey, 1994a).

Brysbaert, Grondelaers, and Ratinckx (2000) recently published a finding that may help us understand why pushing the spelling verification may be an interesting characteristic of the language system. They started from the observation that in many languages morphological information is sometimes revealed by pairs of homophones. In Dutch, for instance, tense information of a verb can be expressed by two homophones (e.g. *zij verwachten [they expect]* vs. *zij verwachtten [they expected]*). The same phenomenon is observed in French (e.g. *il joue [he plays]* vs. *ils jouent [they play]*). Brysbaert et al. (2000) examined how readers deal with this kind of information, and they discovered that it is not more difficult to extract tense information from such homophonic verb forms than from heterophonic verb forms. They hypothesized that this could be due to a direct visual route from print to meaning or to the existence of a very rapid spelling check for these particular words. The present results provide evidence for the existence of such fast spelling verification for pairs of homophones, although it would seem that this process is not the default option (otherwise, it would have been impossible to find phonological priming by homophones in all experiments).

Finally, it may be noted that the existence of some control on the lexical spelling check is in agreement with the many studies that show strategic effects in word processing. Apparently, the very first stages of word processing happen in a rather ballistic way (see also Brysbaert, Van Dijck, & Van de Poel, 1999, for evidence from bilingual word processing), but as soon as the input code makes contact to stored lexico-semantic information, the system seems to be able to introduce some control.

References

Berent, I. (1997). Phonological priming in the lexical decision task: Regularity effects are not necessary evidence for assembly. *Journal of Experimental Psychology: Human Perception and Performance, 23,* 1727-1742.

Berent, I., & Perfetti, C.A. (1995). A ROSE is a REEZ – the 2-cycles model of phonology assembly in reading English. *Psychological Review, 102,* 146-184.

Brysbaert, M. (submitted). Prelexical phonological coding of visual words in Dutch: Automatic after all. *Manuscript submitted for publication.*

Brysbaert, M., Grondelaers, S., & Ratinckx, E. (2000). Sentence reading: Do we make use of orthographic cues in homophones? *Acta Psychologica, 105,* 35-56.

Brysbaert, M., & Mitchell, D. C. (1996). Modifier attachement in sentence parsing: Evidence from Dutch. *Quaterly Journal of Experimental Psychology: Human Experimental Psychology, 49A,* 664-695.

Brysbaert, M., & Praet, C. (1992). Reading isolated words: No evidence for automatic incorporation of the phonetic code. *Psychological Research, 54,* 91-102.

Brysbaert, M., Van Dyck, G., & Van de Poel, M. (1999). Visual word recognition in bilinguals: Evidence from masked phonological priming. *Journal of Experimental Psychology: Human Perception and Performance, 25,* 137-148.

Brysbaert, M., Vitu, F., & Schroyens, W. (1996). The right visual field advantage and the optimal viewing position effect : On the relation between foveal and parafoveal word recognition. *Neuropsychology, 10,* 385-395.

Coltheart, M. (1978). Lexical access in simple reading tasks. In G. Underwood (Ed.), *Strategies of information processing* (pp. 151-216). San Diego, CA: Academic Press.

Coltheart, M., Curtis, B., Atkins, P., & Haller, M. (1993). Models of reading aloud: Dual-route and parallel-distributed-processing approaches. *Psychological Review, 100,* 589-608.

Coltheart, M., Rastle, K., Parry, C., Langdon, R., & Ziegler, J. C. (in press). DRC: A computational model of visual word recognition and reading aloud. *Psychological Review.*

Davelaar, E., Coltheart, M., Besner, D., & Jonasson, J.T. (1978). Phonological recoding and lexical access. *Memory & Cognition, 6,* 391-402.

Ferrand, L., & Grainger, J. (1992). Phonology and orthography in visual word recognition: Evidence from masked non-word priming. *Quaterly Journal of Experimental Psychology, 45A,* 353-372.

Ferrand, L., & Grainger, J. (1994). Effects of orthography are independent of phonology in masked form priming. *Quaterly Journal of Experimental Psychology, 47A,* 365-382.

Frost, R. (1998). Toward a strong phonological theory of visual word recognition: True issues and false trails. *Psychological Bulletin, 123,* 71-99.

Frost, R., Bentin, S., & Katz, L. (1987). Strategies for visual word recognition and orthographic depth: a multilingual comparison. *Journal of Experimental Psychology: Human Perception and Performance, 13,* 104-115.

Gibbs, P., & Van Orden, G. C. (1998). Pathway selection's utility for control of word recognition. *Journal of Experimental Psychology: Human Perception and Performance, 24,* 1162-1187.

Hawkins, H., Reicher, M., Rogers, M., & Peterson, L. (1976). Flexible coding in word recognition. *Journal of Experimental Psychology: Human Perception and Performance, 2,* 380-385.

Humphreys, G.W., & Evett, L.J. (1985). Are there independent lexical and nonlexical routes in word processing? An evaluation of the dual-route theorie of reading. *Behavioral and Brain Sciences, 8* ,689-740.

Humphreys, G.W., Evett, L.J., & Taylor, D.E. (1982). Automatic phonological priming in visual word recognition. *Memory & Cognition, 10,* 576-590.

Jared, D., & Seidenberg, M.S. (1991). Does word identification in reading proceed from spelling to sound to meaning? *Journal of Experimental Psychology: General, 120,* 358-394.

Klinger, M. R., Burton, P. C., & Pitts, G. S. (2000). Mechanisms of unconscious priming: I. Response competition, not spreading activation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 441-455.

Lesch, M.F., & Pollatsek, A. (1993). Automatic access of semantic information by phonological codes in visual word recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 285-294.

Lukatela, G., Lukatela, K., Carello, C., & Turvey, M.T. (1999). Effects of frequency and phonological ambiguity on naming Serbo-Croatian words. *European Journal of Cognitive Psychology, 11,* 1-16.

Lukatela, G., & Turvey, M.T. (1994a). Visual access is initially phonological: 1.

Evidence from associative priming by words, homophones, and pseudohomophones. *Journal of Experimental Psychology: General, 123,* 107-128.

Lukatela, G., & Turvey, M.T. (1994b). Visual access is initially phonological: 2. Evidence from phonological priming by homophones and pseudohomophones. *Journal of Experimental Psychology: General, 123,* 331-353.

Lukatela, G., & Turvey, M.T. (1998). Reading in two alphabets. *American Psychologist, 53,* 1057-1072.

Lukatela, G., & Turvey, M.T. (2000). Do spelling variations affect associative and phonological priming by pseudohomophones? *Perception & Psychofysics, 62,* 196-217.

McQuade, D.V. (1981). Variable reliance on phonological information in visual word recognition. *Language and Speech, 24,* 99-109.

Milota, V.C., Widau, A.A., McMickell, M.R., Juola, J.F., & Simpson, G.B. (1997). Strategic reliance on phonological mediation in lexical access. *Memory & Cognition, 25,* 333-344.

Monsell, S., Graham, A., Hughes, C.H., Patterson, K.E., & Millroy, R. (1992). Lexical and sublexical translation of spelling to sound – Strategic anticipation of lexical status. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18,* 452-467.

Perfetti, C.A., & Bell, L. (1991). Phonemic activation during the first 40 ms of word identification: Evidence from backward masking and priming. *Journal of Memory and Language, 30,* 473-485.

Perfetti, C.A., Bell, L., & Delaney, S. (1988). Automatic phonetic activation in silent word reading: Evidence from backward masking. *Journal of Memory and Language, 27,* 59-70.

Pollatsek, A., & Well, A. D. (1995). On the use of counterbalanced designs in cognitive research: A suggestion for a better and more powerful analysis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 785-794.

Pugh, K.R., Rexer, K., & Katz, L. (1994). Evidence of flexible coding in visual word recognition. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 807-825.

Van Orden, G.C. (1987). A ROWS is a ROSE: Spelling, sound, and reading. *Memory*

& Cognition, 15, 181-198.

Xu, B., & Perfetti, C. A. (1999). Nonstrategic subjective threshold effects in phonemic masking. *Memory & Cognition, 27,* 26-36.

Zevin, J. D., & Balota, D. A. (2000). Priming and attentional control of lexical and sublexical pathways during naming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 121-135.

Appendix A: Word stimuli used in Experiments 1, 2, and 3 to examine homophonic priming. Each row identifies the target, its associate, the homophone of the associate, and the graphemic control word.

1. liefde	HART	HARD	HARS
2. boog	PIJL	PEIL	PAAL
3. riool	RAT	RAD	RAS
4. vlees	RAUW	ROUW	BOUW
5. zee	KRAB	KRAP	KRAT
6. berg	STEIL	STIJL	STIJF
7. stof	LAP	LAB	LAF
8. jas	BONT	BOND	BONS
9. muziek	NOOT	NOOD	POOT
10. drugs	HIGH	HAAI	HOME
11. koud	IJS	EIS	LES
12. brood	RIJZEN	REIZEN	REIKEN
13. been	BOT	BOD	BOM
14. onderbroek	SLIP	SLIB	SLOP
15. vis	GRAAT	GRAAD	GRAAN
16. baby	SLAB	SLAP	SLAK
17. rechts	LINKS	LYNX	LANS
18. boek	LEZER	LASER	LEVER
19. zacht	MILD	MILT	MIME
20. gras	WEI	WIJ	WAS
21. pijn	LIJDER	LEIDER	LADDER

Appendix B: Word stimuli used in Experiments 1, 2, and 3 to examine pseudohomophonic priming. Each row identifies the target, its associate, the pseudohomophone of the associate, and the graphemic control non-word.

1. hand	ARM	ARREM	ARS
2. sneeuw	BERG	BERCH	BERS
3. warm	JAS	IAS	VAS
4. nacht	DAG	DACH	DAP
5. goed	SLECHT	SLEGT	SLEPT
6. meisje	DOCHTER	DOGTER	DOPTER
7. kerk	PAUS	POUS	PEUS
8. naald	DRAAD	DRAAT	DRAAS
9. boom	PALM	PALLEM	RALM
10. man	VROUW	VRAUW	VREUW
11. bord	KRIJT	KREIT	KRAAT
12. druk	STAD	STAT S	TAS
13. strand	ZAND	ZANT	ZANK
14. peper	ZOUT	ZAUT	ZUUT
15. plakken	LIJM	LEIM	LAAM
16. kind	STOUT	STAUT	STUUT
17. rook	PIJP	PEIP	POUP
18. appel	VRUCHT	WRUCHT	KRUCHT
19. recht	LIJN	LEIN	LOEN
20. wind	STORM	STORREM	STORS
21. wit	TAND	TANT	TANS

Appendix C: Non-word trials used in Experiments 2 and 3 based on homophonic base stimuli. Each row identifies the target with between brackets the original word, the associate, the homophone, and the graphemic control word.

1. lijs (vijs)	BOUT	BOUD	MOUT
2. laby (baby)	DOOP	DOPE	DOOF
3. brus (brug)	PONT	POND	PAND
4. hons (hond)	PUP	PUB	PUL
5. oten (eten)	KOOK	COKE	KOER
6. lout (fout)	MIS	MISS	MIME
7. tagel (nagel)	VIJL	VEIL	VETO
8. nater (water)	POEL	POULE	DOEL
9. zwaak (zwaar)	LOOD	LOOT	LOOM
10. kanan (kanon)	KRUIT	KRUID	KRUIS
11. grak (gras)	WEIDEN	WIJDEN	WANDEN
12. hoom (hooi)	MIJT	MEID	MAAT
13. bif (bij)	RAAT	RAAD	RAAM
14. pout (post)	MAIL	MEEL	MUIL
15. kokker (kikker)	PAD	PAT	PAK
16. lamaai (lawaai)	LUID	LUIT	LUIS
17. wos (bos)	EIK	IJK	PAK
18. dif (dik)	KONT	KOND	KOOI
19. il (ik)	MIJ	MEI	MOS
20. eilang (eiland)	WAD	WAT	WAL
21. kos (koe)	WEIDE	WIJDE	WOEDE

Appendix D: Non-word trials used in Experiments 2 and 3 based on pseudohomophonic base stimuli. Each row identifies the target with between brackets the original word, the associate, the pseudohomophone, and the graphemic control non-word.

1. bielen (wielen)	AUTO	OUTO	EUTO
2. roning (honing)	BIJ	BEI	BOG
3. nak (dak)	HUIS	HUYS	HURS
4. petter (letter)	CIJFER	SIJFER	PIJVER
5. mistruik (misbruik)	MACHT	MAGT	MART
6. goel (geel)	KAAS	CAAS	TAAS
7. knoos (knoop)	HEMD	HEMT	HEMP
8. belukkig (gelukkig)	BLIJ	BLEI	BLAS
9. vuik (buik)	DARM	DARREM	DARP
10. diek (dier)	HOND	HONT	HONS
11. zeek (zeep)	SOP	SOB	KOB
12. paten (pater)	PIJ	PEI	POE
13. zol (zon)	KUST	KUSD	KUSP
14. teeuw (leeuw)	TIJGER	TEIGER	TROGER
15. krui (trui)	MOUW	MAUW	MEUW
16. staas (staal)	IJZER	EIZER	BEZER
17. trakken (trekken)	TOUW	TAUW	TEUW
18. moos (roos)	ZALM	ZALLEM	ZALK
19. voem (voet)	KOUS	KAUS	ROUS
20. baam (baan)	WEG	WECH	WER
21. oken (oren)	KONIJN	KONEIN	KONKEN

Appendix E: Pseudohomophonic non-word trials used in Experiment 4 based on homophonic base stimuli. Each row identifies the target with between brackets the original word, the associate, the homophone, and the graphemic control word.

1. veis (vijs)	BOUT	BOUD	MOUT
2. babie (baby)	DOOP	DOPE	DOOF
3. bruch (brug)	PONT	POND	PAND
4. hont (hond)	PUP	PUB	PUL
5. eeten (eten)	KOOK	COKE	KOER
6. faut (fout)	MIS	MISS	MIME
7. nachel (nagel)	VIJL	VEIL	VETO
8. watur (water)	POEL	POULE	DOEL
9. zwaer (zwaar)	LOOD	LOOT	LOOM
10. kannon (kanon)	KRUIT	KRUID	KRUIS
11. chras (gras)	WEIDEN	WIJDEN	WANDEN
12. hooj (hooi)	MIJT	MEID	MAAT
13. bei (bij)	RAAT	RAAD	RAAM
14. posd (post)	MAIL	MEEL	MUIL
15. kicker (kikker)	PAD	PAT	PAK
16. lawaaj (lawaai)	LUID	LUIT	LUIS
17. blat (blad)	EIK	IJK	PAK
18. gad (gat)	KONT	KOND	KOOI
19. zelv (zelf)	MIJ	MEI	MOS
20. eilant (eiland)	WAD	WAT	WAL
21. coe (koe)	WEIDE	WIJDE	WOEDE

Appendix F: Pseudohomophonic non-word trials used in Experiment 4 based on pseudohomophonic base stimuli. Each row identifies the target with between brackets the original word, the associate, the pseudohomophone, and the graphemic control non-word.

1. reiden (rijden)	AUTO	OUTO	EUTO
2. hooning (honing)	BIJ	BEI	BOG
3. dack (dak)	HUIS	HUYS	HURS
4. lettur (letter)	CIJFER	SIJFER	PIJVER
5. misbruyk (misbruik)	MACHT	MAGT	MART
6. cheel (geel)	KAAS	CAAS	TAAS
7. knoob (knoop)	HEMD	HEMT	HEMP
8. gelukkich (gelukkig)	BLIJ	BLEI	BLAS
9. buyk (buik)	DARM	DARREM	DARP
10. kad (kat)	HOND	HONT	HONS
11. zeeb (zeep)	SOP	SOB	KOB
12. patur (pater)	PIJ	PEI	POE
13. zant (zand)	KUST	KUSD	KUSP
14. leew (leeuw)	TIJGER	TEIGER	TROGER
15. truy (trui)	MOUW	MAUW	MEUW
16. stael (staal)	IJZER	EIZER	BEZER
17. trecken (trekken)	TOUW	TAUW	TEUW
18. lekkur (lekker)	ZALM	ZALLEM	ZALK
19. sgoen (schoen)	KOUS	KAUS	ROUS
20. straad (straat)	WEG	WECH	WER
21. ooren (oren)	KONIJN	KONEIN	KONKEN

Table 1
Naming latencies (in milliseconds) experiment 1

Homophonic priming	Naming Latencies (MSec)		Pseudohomophonic priming
Associate	580	563	Associate
PIJL – boog			PALM – boom
Homophone	580	564	Pseudohomophone
PEIL – boog			PALLEM – boom
Visual Control	606	587	Visual Control
PAAL – boog			RALM – boom
Net associative priming	26	24	Net associative priming
Net homophonic priming	26	23	Net pseudohomophonic priming

Table 2
Reaction times and errors experiment 2

Homophonic priming	Reaction times in MSec (% errors)		Pseudohomophonic priming
Associate	565 (3.4)	571 (1.7)	Associate
PIJL – boog			PALM – boom
Homophone	561 (3.0)	575 (3.4)	Pseudohomophone
PEIL – boog			PALLEM – boom
Visual Control	589 (5.0)	605 (3.4)	Visual Control
PAAL – boog			RALM – boom
Net associative priming	24	34	Net associative priming
Net homophonic priming	28	30	Net pseudohomophonic priming

Table 3

Reaction times and errors experiment 3

Homophonic priming	Reaction times in MSec (% errors)		Pseudohomophonic priming
Associate PIJL – boog	516 (2.7)	523 (1.4)	Associate PALM – boom
Homophone PEIL – boog	539 (5.1)	528 (6.4)	Pseudohomophone PALLEM – boom
Visual Control PAAL – boog	541 (5.7)	545 (7.4)	Visual Control RALM – boom
Net associative priming	25	22	Net associative priming
Net homophonic priming	2	17	Net pseudohomophonic priming

Table 4

Reaction times and errors experiment 4

Homophonic priming	Reaction times in MSec (% errors)		Pseudohomophonic priming
Associate PIJL – boog	576 (1.4)	569 (1.4)	Associate PALM – boom
Homophone PEIL – boog	609 (3.0)	574 (2.4)	Pseudohomophone PALLEM – boom
Visual Control PAAL – boog	602 (2.3)	600 (1.7)	Visual Control RALM – boom
Net associative priming	26	31	Net associative priming
Net homophonic priming	-7	26	Net pseudohomophonic priming